Subject

FODO LATTICE FOR STORAGE RINGS

We assume a separated-function FODO lattice with 6 beam intersecting regions, a bending magnet field of 20 kG for 100 BeV, and a radius of $\frac{1}{3}$ km.

(1) Discussions with experimentalists indicate that the free drift space on either side of the intersecting point should be about 30 m long and beam separation at the end of 30 m should be about 1.5 m. This gives an intersecting angle α of about .05.

(2) In each sextant then the outer arc should have a bending angle 2x.05=0.1 rad larger than that of the inner arc.

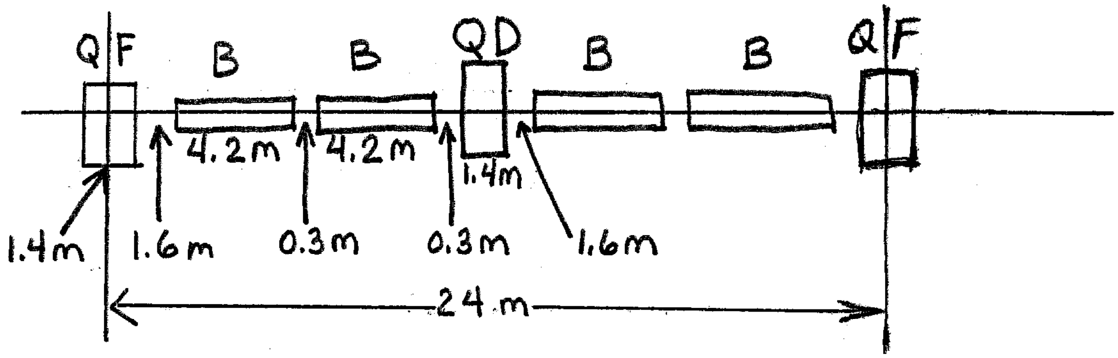
(3) If each normal cell is adjusted to give a bending angle of 0.1 rad, then the outer arc should contain one more cell than the inner.

(4) The mean of the numbers of cells in the outer and the inner arc should produce a bending angle of $\frac{\pi}{3}$. The mean number of cell per sextant is therefore $\frac{\pi}{3}/0.1=10.47$. The number of cells in the outer and inner arcs should then be 11 and 10 respectively.

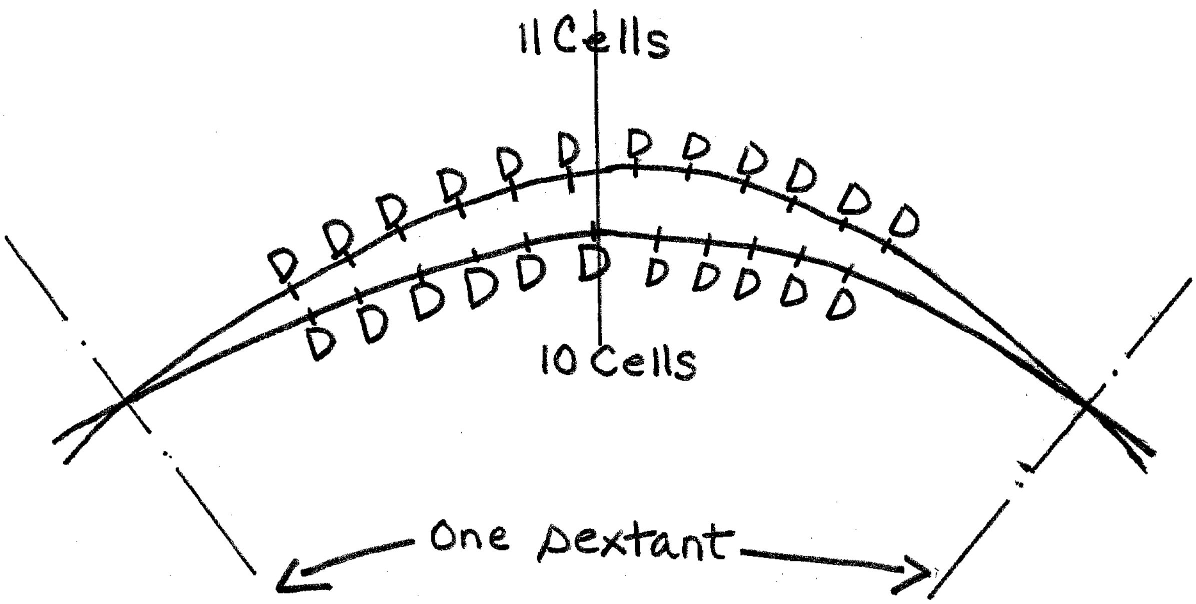
(5) The exact bend angle per cell is hence $\frac{\pi}{3}/10.5 =$ 0.099733 and the exact intersecting angle is $\alpha = \frac{0.099733}{2} =$ .049867 rad.

(6) We assume 4 bending magnets per cell. Then each bending magnet will be 4.2 m long having a field of B = 19.987 kG for 100 BeV ($B\rho$ =3366.8 kGm).

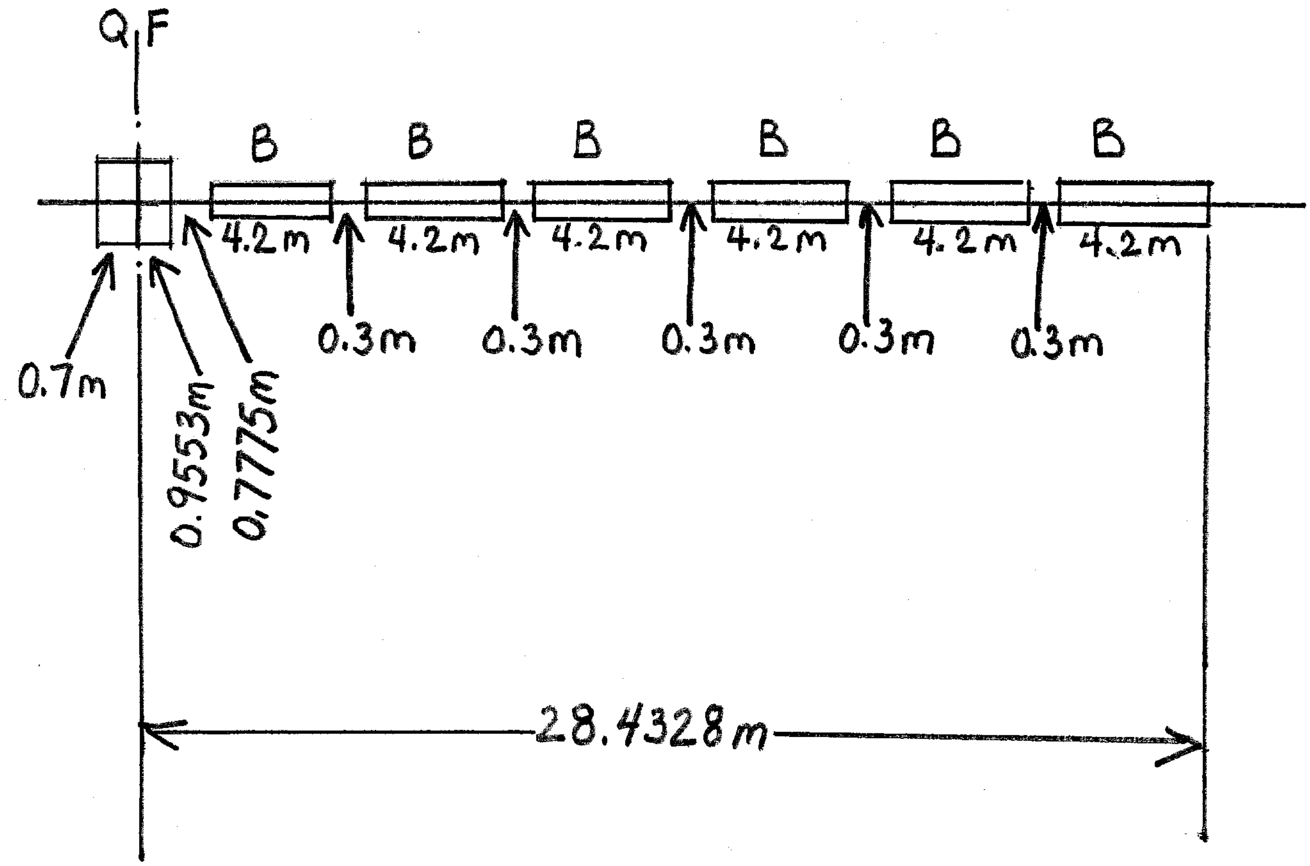
(7) Assuming a cell length of ℓ_c=24 m, for minimum betatron-oscillation excursion the quadrupole strength is given by $\frac{B'\ell_Q}{B\rho} = \frac{2.48}{\ell_c} = .1033\ \mathrm{m}^{-1}$ or $B'\ell_Q$= 347.9 kG. We then take ℓ_Q=1.4 m and B'=248.5 kG/m. A normal cell then looks like



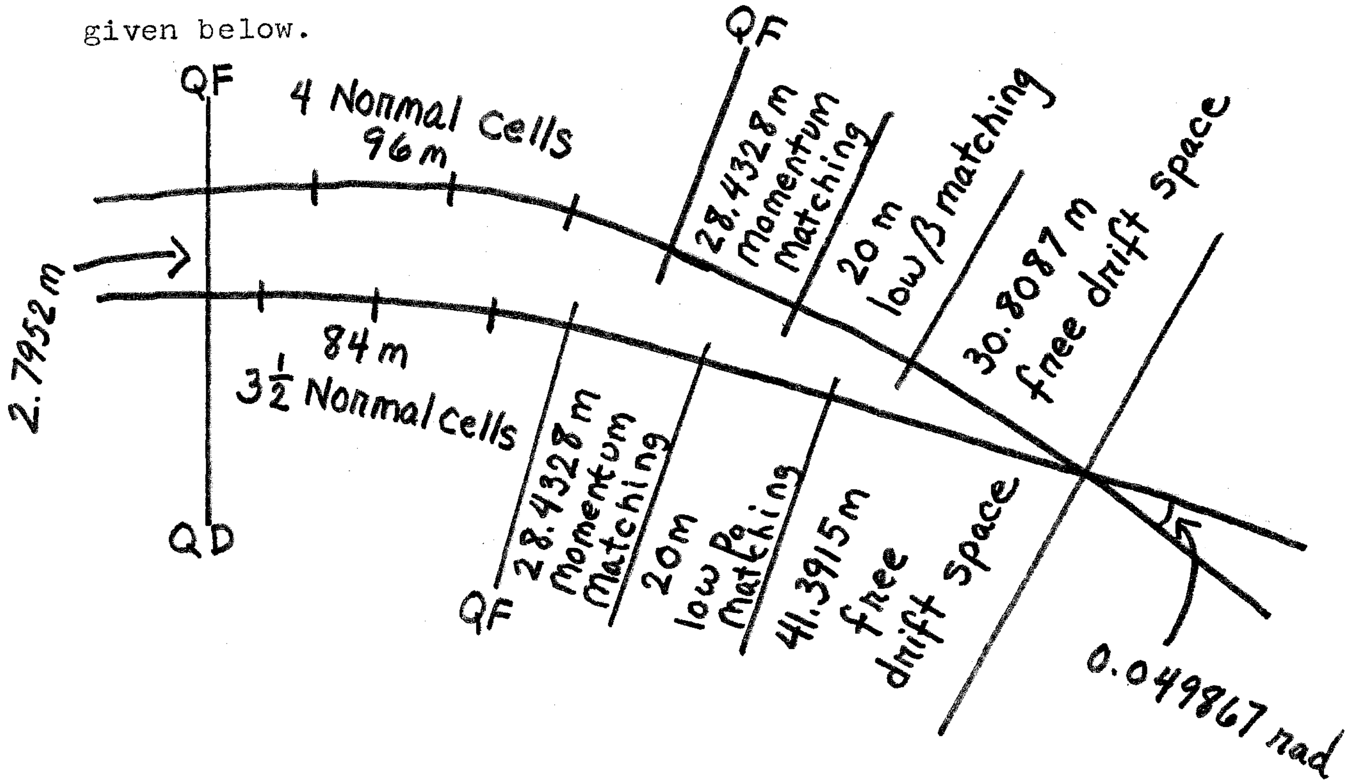
And a sextant looks like



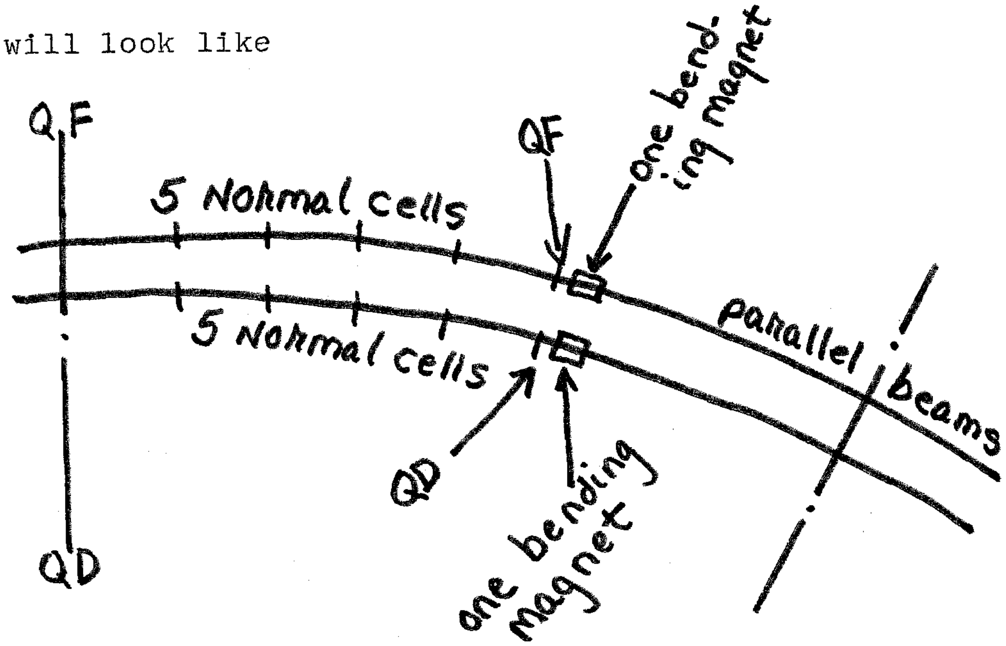
(8) For maximum luminosity we want the intersecting region to be non-dispersive ($x_p = x_p' = 0$). Hence we modify the ends of the lattice at the intersecting region to give momentum matching. The momentum match can be accomplished either with 4 bending magnets beyond a QD or 6 bending magnets beyond a QF without having to leave excessively long drift spaces in between magnets. These two arrangements are in fact rather similar because with 4 bending magnets beyond the QD, the defocusing quadrupole has to be weakened to the point that it is effectively non-existing. We have therefore shortened the lattice at the end of the intersecting region by $1\frac{1}{2}$ cells. The lattice then ends in a QF which together with the 6 bending magnets beyond is adjusted to produce a non-dispersive beam in the intersecting region. The exact parameters of the momentum matching section are



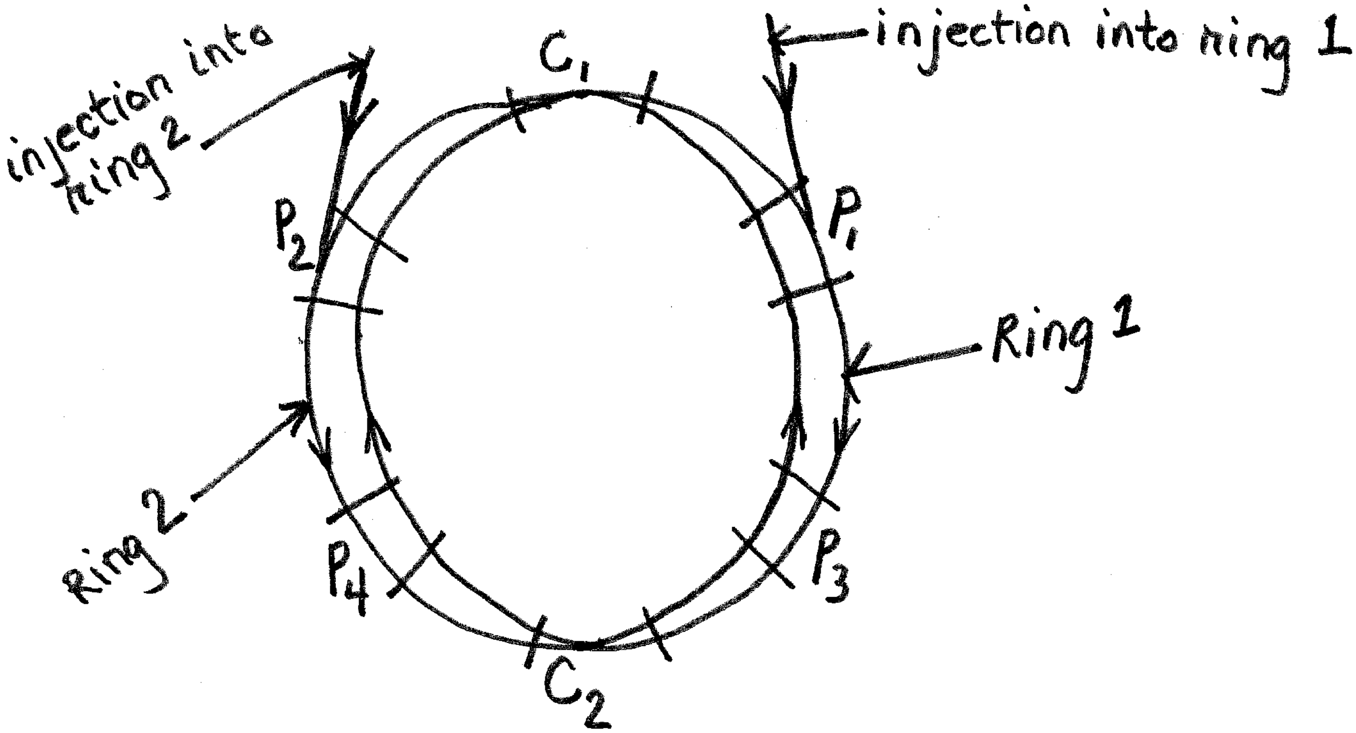
(9) To further increase the luminosity of the intersecting point for given beam current we have to reduce the vertical beam height (proportional to $\sqrt{\beta y}$) at the intersecting point. We therefore place a quadrupole triplet or quadruplet beyond the 6 bending magnet to obtain a low βy at the intersecting point. Since quadrupoles are non-dispersive in the first order, these low βy quadrupoles will not foul up the non-dispersive nature of the beam. These low-βy quadrupoles are being designed using computor matching programs. Based on past experience we expect that these quadrupoles will not have to occupy more than 20 m of the beam length beyond the 6 bending magnets. This should leave clear drift spaces of about 30 m on each side of the intersecting point. The overall geometry of half a sextant is given below.



(10) We started on the assumption that there are 6 beam crossings. Clearly this is not necessary. To still keep the two rings identical in circumference and shape we can have 2 beam crossings and leave the other 4 insertions as parallel beam insertions. To do this instead of having 22 and 20 bending magnets respectively on the outer and the inner half sextants on either side of a beam crossing we should have 21 bending magnets or 5 normal cells plus one bending magnet on both the outer and the inner half sextants. This will look like



And the overall geometry will look like.

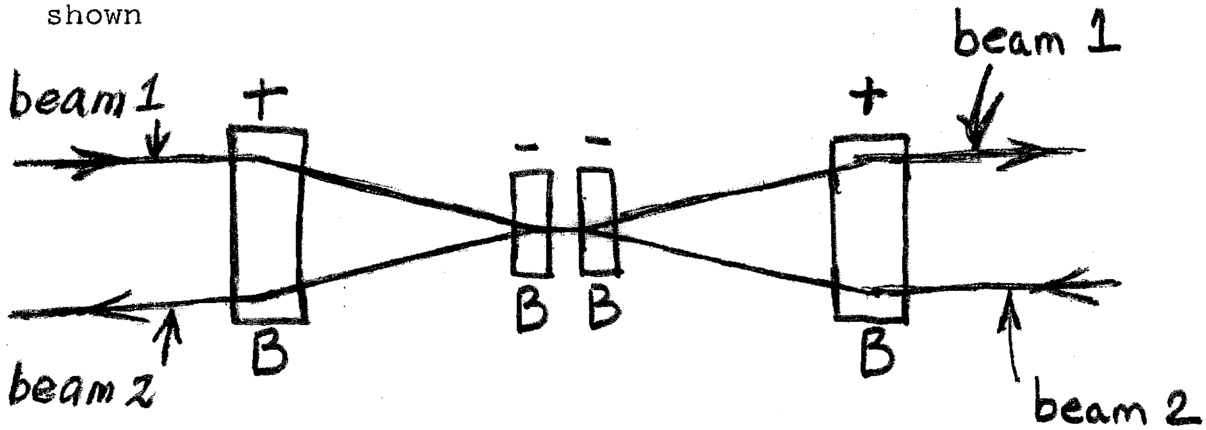


Where C_1 and C_2 are crossing beam insertions described above and P_1, P_2, P_3 and P_4 are parallel beam insertions. The outer straight section in P_1 is used for injection into ring 1 and the outer straight section in P_2 is used for injection into ring 2, whereas the inner straight sections in P_1 and P_2 will be used for dumping the beams in ring 2 and ring 1 respectively.

(11) Again the ends of the normal lattice in a parallel beam insertion (P) can be modified for matching. Both the outer and the inner insertions in a parallel beam straight section are presumably symmetric insertions with reflection symmetry about the midpoint. But the beam characteristics in the outer insertion should be adjusted to match the require-

ments for injection and those in the inner insertion should be adjusted to match the requirements for beam dump. Both are being studied using computor programs.

(12) The remaining parallel beam straight sections P_3 and P_4 can be used for colliding beam experiments without beam crossing by the addition of 4 beam steering magnets as shown



But, of course, the dispersive and betatron-oscillation properties and matching for such an arrangement have to be further studied.

(13) The SYNCH output for a normal cell is attached.

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CYA     14    1 //  QF    00    B    0    B    0    QD   QD   00   B    0    B
                //  0     QF
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TATRON FUNCTIONS THROUGH C .

S	NAME	PSIX/2PI	BETAX	ALPHAX	XEQ	DXEQ	WX	PSIY/2PI	BETAY	ALPHAY	Y
0.00000	QF	0.00000	39.55115	0.00000	2.18394	.00275	6.28897	0.00000	10.20525	.00016	0.0
.70000	00	.00285	38.15012	1.97728	2.14648	-.10946	6.17658	.01077	10.62718	-.61015	0.0
2.30000	B	.01012	32.15229	1.77137	1.97135	-.10946	5.67030	.03258	12.91027	-.81677	0.0
6.50000	0	.03691	19.54399	1.23092	1.56404	-.08452	4.42086	.07263	22.03868	-1.35603	0.0
6.80000	B	.03940	18.81702	1.19231	1.53868	-.08452	4.33786	.07476	22.86409	-1.39467	0.0
11.00000	0	.08639	11.07231	.65186	1.23609	-.05959	3.32751	.09787	36.83367	-1.93039	0.0
11.30000	QD	.09078	10.69278	.61325	1.21871	-.05959	3.26998	.09315	38.00345	-1.96888	0.0
12.00000	QD	.10148	10.26861	.00000	1.19834	.00265	3.20447	.10201	39.39806	.00065	0.0
12.70000	00	.11219	10.69278	-.61325	1.22195	.06499	3.26998	.10487	38.00106	1.97010	0.0
14.30000	B	.13386	12.98464	-.81916	1.32593	.06499	3.60342	.11217	32.02618	1.76458	0.0
18.50000	0	.17370	22.13452	-1.35961	1.65127	.08992	4.70473	.13908	19.45426	1.22780	0.0
18.80000	B	.17582	22.96187	-1.39822	1.67819	.08992	4.79185	.14158	18.72918	1.18914	0.0
23.00000	0	.19884	36.97534	-1.93867	2.10819	.11486	6.08074	.18883	11.00555	.64925	0.0
23.30000	QF	.20011	38.15012	-1.97728	2.14265	.11486	6.17658	.19325	10.62763	.61050	0.0
24.00000	QF	.20296	39.55115	-.00000	2.18394	.00275	6.28897	.20402	10.20525	.00016	0.0

```
      QX =     .20296284              XRMS =    1.69778071         QY =      .20401874            YRM
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OUT3   WMA     1      //  C
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EMENT MATRICES

ELEMENT	RX(I,J)				RY(I,J)	
C	.29125955	37.83636976	1.44375764	0.	.28505740	9.78229366
	-.02418752	.29125955	.05477378	0.	-.09392770	.28475536
	0.	0.	1.	0.		
	[illegible]	1.65193277	.04647280	1.		